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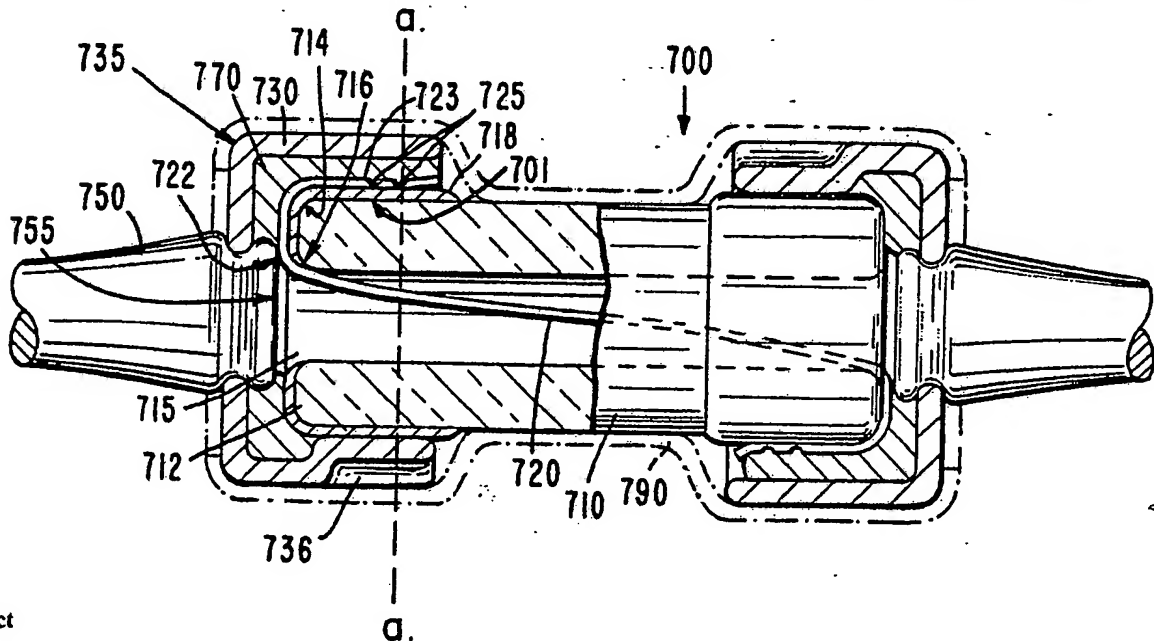
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(54) Title: SURFACE-METALIZED, BONDED FUSE WITH MECHANICALLY-STABILIZED END CAPS



(57) Abstract

The body (410 in Fig. 4a) of the disclosed fuse includes connective portions (401, 402) having surface metalization (408, 418) to which corresponding connective portions (523, 529 in Fig. 5) of the fusible element (520) are respectively bonded (525). A metalization conductive ceramic may be more-specifically utilized for the fuse body, while those portions (414a, 416a in FIG. 4a) of the body which interface with the fusible element may additionally be contoured so as to lessen the severity of element-severance forces otherwise experienced. When the fuse's connective portions yet-more-specifically comprise the opposite ends (412, 417) of a fuse body which is elongated, end caps (730 in Fig. 7a) may be electrically joined (770) to the surface-metalized fuse ends. An enhanced degree of mechanical stability may also be achieved by further providing stabilizing geometrical expedients (732, 734, 736 in Fig. 7b) for the fuse/cap interface.

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<p>(57) Abstract</p> <p>The body (410 in Fig. 4a) of the disclosed fuse includes connective portions (401, 402) having surface metalization (408, 418) to which corresponding connective portions (523, 529 in Fig. 5) of the fusible element (520) are respectively bonded (525). A metalization conductive ceramic may be more-specifically utilized for the fuse body, while those portions (414a, 416a in FIG. 4a) of the body which interface with the fusible element may additionally be contoured so as to lessen the severity of element-severance forces otherwise experienced. When the fuse's connective portions yet-more-specifically comprise the opposite ends (412, 417) of a fuse body which is elongated, end caps (730 in Fig. 7a) may be electrically joined (770) to the surface-metalized fuse ends. An enhanced degree of mechanical stability may also be achieved by further providing stabilizing geometrical expedients (732, 734, 736 in Fig. 7b) for the fuse/cap interface.</p>		

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SURFACE-METALIZED, BONDED FUSE
WITH MECHANICALLY-STABILIZED END CAPS

1 BACKGROUND OF THE INVENTION

1. Field of the Invention

 The invention relates in general to electrical
5 fuses and in particular to improved construction
 principles for such fuses.

 It is to be noted, however, that while the present
 invention will be described here with reference to the
 particularized application of electrical fuses, the
10 invention is not limited to such applications. Those
 having ordinary skill in the art and access to the
 teachings of this invention will recognize additional
 applications within the invention's scope.

15 2. Description of the Prior Art

 FIG. 1 illustrates a cross-sectional view of a
 typical prior-art fuse 100. The fuse includes a
 tubular, ceramic body 110 and a wire fusible element
 120. Fusible element 120 extends through the hollow
20 central core 115 of fuse body 110 and includes looped
 ends 122 and 127 respectively folded over fuse-body
 ends 112 and 117. The body ends and fusible-element
 loops are encased within respective end caps 130 and 140
 which also hold lead wires 150 and 160. Conductive
25 contact is provided by solder 180 and 190. The entire
 assembly is encased within a surrounding shrink sleeve
 170.



1 Two aspects of such fuses have now been identified
as giving rise to a number of shortcomings which have
been found to become especially pronounced in the
installation stages of the larger assemblies in which
5 the fuses may be employed as component elements. These
difficulty-inducing aspects include first, the solder
terminations 180 and 190 and second, the inherent con-
figuration of the end caps 130 and 140. The associated
consequential problems include both non-uniformities
10 and instabilities in fuse electrical, thermal and
mechanical properties. These causal factors and their
consequential difficulties will now be discussed in greater
detail.

FIGS. 2a and 2b illustrate the adverse consequences
15 entailed in attempting to form a solder joint between
an end cap and a fusible element juxtaposed a ceramic
fuse body. FIG. 2a represents a 50X transverse cross-
sectional view taken along line a--a in FIG. 1, while the
enlarged 100X view of FIG. 2b focuses more specifically
20 on the vicinity of the fusible element. The ceramic
nature of the fuse body 210 does not lend itself to a
capillary-type adhesion action with respect to solder
270. As a result, gaps 272 and 274 are typically
encountered at the interface between body surface 215,
25 fusible element 220 and solder 270. As is exemplified
by the figure, it has been found to be not uncommon for
only approximately 30% of the fusible-element surface to
be effectively contacted by the adjacently-disposed
solder. This unpredictable degree of contact consequen-
30 tially produces a resistance across the fuse which is
non-uniform from one fuse to the next. The resulting
variation in inter-fuse electrical properties in turn
introduces an element of uncertainty into end-use
overall circuit design. It may also be noted that
35 because such solder junctions are typically formed only

1 after the end cap has been inserted over the looped end
of the fusible wire, the contacts are not readily
susceptible to quality-control inspection.

5 A second source of difficulty in the prior-art
fuse construction concerns the positioning of the end
cap around the ceramic body. This situation is schema-
tically illustrated in the transverse cross-sectional
view of FIG. 3a where the fuse body 310 of a given
external diameter d_1 is shown to be surrounded by the
10 end cap 330 of internal diameter d_2 . Interposed
between the body and cap is the fusible element 320.
The consequential lack of concentricity between the
body 310 and the end cap 330 is readily apparent. In
practical commercial situations, this lack of concen-
15 tricity is rendered more pronounced by the typical
desire to form the end cap 330 of sufficiently-large
internal diameter d_2 so as to accommodate fusible
elements 320 of different cross-sectional diameters d_3
and hence of different breakdown levels.

20 One problem following from the lack of concentricity
is a randomness in the positional distribution of end
cap 330 with respect to both the body 310 and the inter-
posed fusible element 320. This randomness introduces
a further measure of non-uniformity in the electrical
25 properties of the overall fuse.

An associated problem follows from the readily-
destablized nature of the solder-based end junction
when the otherwise-completed fuse is subsequently sub-
jected to elevated-temperature operations. Such opera-
30 tions include the application of the shrink sleeve
during fuse manufacture, as well as the additional
external soldering performed when the fuse is installed
within larger assemblies such as printed circuit boards.
A common collateral consequence of the elevated tempera-
35 tures is a remelting of the solder within the fuse end.



1 With mechanical interlock between the various components
of the conventional fuse being basically provided by
only the interfacing solder and the surrounding shrink
sleeve, such remelting has been found to have an adverse
5 effect on the mechanical positioning of the end cap.
The lack of concentricity illustrated in FIG. 3a,
together with the absence of other available physical
interlock mechanisms, can produce a post-elevated-
temperature condition such as the one illustrated in
10 FIG. 3b. Here the readily-alterable nature of the
solder junction between the end cap 340 and the body
310 is seen to permit the development of an excessive
tilt of end cap 340 with respect to body end 317.
Among the disadvantageous consequences of an excessive
15 tilt of this nature are the creation of shearing forces
between the diagonally-disposed end-cap portion 342 and
the typically-sharp corner portion 318 of fuse-body end
317. Such forces may cause either a reduction in the
effective cross-sectional area of the fusible element
20 320 because of nicking at the 318/342 interposition
point, or an actual complete severance. It may also be
noted that the typically similarly-sharp corner 319 may
likewise produce either nicking or actual severance
when the fusible element 320 is subjected to thermally-
25 induced tensile stresses. Such stresses include those
commonly encountered in spacecraft when experiencing
temperature extremes such as -55°F or lower.

It is to be further noted that another collateral
consequence of such solder remelting is a physical
30 alteration of the previously-discussed junction between
the solder and the fusible element. A practically-
unavoidable effect of this physical alteration is an
associated additional alteration in the electrical
characteristics of the junction and hence of the overall
35 fuse.

1 In view of these disadvantageous properties of
the prior-art fuses, a need clearly exists for significant
improvements in fuse construction.

5 SUMMARY OF THE INVENTION

The shortcomings of the prior-art fuses are
overcome by the disclosed fuse whose body includes
connective portions having surface metalization to
which corresponding connective portions of the fusible
10 element are respectively bonded.

A metalization-conducive ceramic may be more-
specifically utilized for the fuse body, while those
portions of the body which interface with the fusible
element may additionally be contoured so as to lessen
15 the severity of element-severance forces otherwise
experienced.

When the fuse's connective portions yet-more-
specifically comprise the opposite ends of a fuse body
which is elongated, end caps may be electrically joined
20 to the surface-metalized fuse ends. An enhanced degree
of mechanical stability may also be achieved by further
providing stabilizing geometrical expedients for the
fuse/cap interface.

25 BRIEF DESCRIPTION OF THE DRAWINGS

Advantages and aims of the present invention
will become apparent from a study of the following
specification, especially when considered in
conjunction with the accompanying drawings, in which:

30 FIG. 1 is a cross-sectional view of a
typically-constructed prior-art electrical fuse;

FIGS. 2a and 2b present enlarged cross-
sectional views of the poor nature of the prior art's
non-capillary-assisted solder interface with respect to
35 a fusible element interposed between a ceramic fuse
body and a surrounding end cap;



1 FIG. 3a shows the typical misaligned, non-concentric nature of the relationship between a prior-art fuse body and its associated end cap;

5 FIG. 3b illustrates the excessive tilt and consequential generation of fusible-element shearing forces following from the lack of a thermally-stable physical interlock between a fuse body and a nonconcentric end cap;

10 FIG. 4a shows various features of the inventive fuse body with its applied metalization layers;

 FIGS. 4b and 4c present example realizations for the concept of contoured surfaces of fusible-element/fuse-body interface;

15 FIG. 5 illustrates various aspects of the bonding of a fusible element to the prepared fuse body of FIG. 4a;

20 FIGS. 6a, 6b, 6c, 6d and 6e respectively present end-cap and fuse-body cross-sectional views of specific realizations for end-cap mechanical-stabilization expedients; and

 FIGS. 7a and 7b present longitudinal and transverse cross-sectional views of a composite electrical fuse constructed in accordance with many of the principles of the present invention.

25

DETAILED DESCRIPTION OF THE INVENTION

I. Overview

30 In its more-specific embodiments, the inventive fuse entails an elongated body comprised of a metalization-conductive ceramic material. This body includes contoured, surface-metalized connective ends to which the fusible element is welded and to which mechanically-stabilized-end caps are soldered. The component features of this particularized fuse and the manner in which these
35 features enable the shortcomings of the prior art to be



1 overcome will be individually discussed with reference
to FIGS. 4 through 6. FIG. 4 will provide the context
for a description of the fuse body and its surface
metalization, while the context for a review of the
5 bonding of the fusible element will be provided by FIG.
5. Following an examination with reference to FIG. 6
of the mechanically-stabilized end caps, the detailed
description will conclude with a specific-feature
summary presented in the context of the composite
10 embodiment illustrated in FIG. 7.

It may be noted parenthetically that in view of
the largely-symmetrical nature of many aspects of the
preferred form of the inventive fuse, the following
discussion will for convenience tend to focus on only a
15 given one of otherwise symmetrically-disposed features.

II. Embodiment Details

A. Fuse Body

The subject electrical fuse basically entails
20 first, a fuse body having first and second connective
portions; second, surface metalization applied to these
portions; and third, a fusible element having what may
for convenience be regarded as third and fourth connective
portions respectively bonded to the surface metalization
25 of the first and second connective portions of the fuse
body.

With reference to FIG. 4a, an example
embodiment of the subject fuse thus first includes the
illustrated body 410. The associated connective
30 portions, to which the below-described fusible element
will later be shown to be bonded, appear as respective
first and second connective portions 401 and 402.
Applied to portions 401 and 402 are the illustrated
respective surface-metalization layers 408 and 418.

35



1 In view of the component metalization specified
to be carried by the fuse body, the body 410 is itself
advantageously comprised of a material which while
remaining electrically insulative is nevertheless
5 conductive to the adhesion thereon of an exterior metal-
ization layer. Although a number of materials are
suitable for this purpose, body 410 may in general be
conveniently comprised of a ceramic material. One
especially-advantageous ceramic is alumina (aluminum
10 oxide, Al_2O_3). For a preferred form of the invention,
body 410 comprises an alumina ceramic of at least
approximately 92% alumina.

 In its volumetric geometry, fuse body 410 may
take on a variety of forms. One class of specific
15 forms provides the fuse body with first and second end
portions, such as respective end portions 412 and 417
in FIG. 4. In the more-specific context of a fuse body
having end portions of this nature, the previously-
identified connective portions 401 and 402 can be seen
20 to respectively comprise selected sections of these
portions 412 and 417. It may be noted parenthetically
that for preferred embodiments of the invention, such
end portions are configured to receive end-cap assemblies,
as will be further discussed below.

25 In yet-more-specific embodiments of the
invention, it becomes advantageous to provide the fuse
body with a substantially-elongated geometry, in which
case the end portions may simply become the opposite
ends of the fuse body. Body 410 is shown to possess a
30 substantially-elongated, oppositely-disposed-end-portion
geometry of this nature.

1 With regard to making provision for the
subsequently-mounted fusible element, it may be noted
that as between a fusible element of arbitrary geometry
and a fuse body basically of also-arbitrary geometry,
5 it would be possible to simply mount the fusible element
on the exterior of an otherwise-essentially-smooth
body surface. However, an otherwise-arbitrarily-
shaped fuse body may advantageously be provided with
a receptacle for the protective carrying of the fusible
10 element. In those preferred instances where the fusible
element is given an essentially-elongated shape, the
protective receptacle may take the form of an elongated
conduit configured as either part of the fuse-body's
surface geometry or its interior. Where the fuse body
15 is also more-specifically given not only a likewise-
essentially-elongated shape but also an either rectangular
or cylindrical volumetric geometry, the elongated
conduit is conveniently made in the form of an axial
shaft, schematically illustrated in FIG. 4a as central
20 shaft 415. With an axial shaft of this nature, body
410 preferably takes a substantially cylindrically-
tubular form.

 It will be recalled that an examination of
the prior-art fuses revealed that the presence of sharp
25 edges at critical portions of the interface between the
body 410 and a subsequently-mounted fusible element
detrimentally contributed to the generation of shearing
forces. With surfaces of critical fusible-element/fuse-
body interface being established by those areas of
30 element/body juxtapositional contact which would other-
wise tend to generate shearing forces, such interface
surfaces may accordingly be provided with contoured
edges designed to reduce the severity of this interface.

35



1 In typical specific embodiments, interface surfaces of
this nature will be located at the end portions of the
fuse body. Thus in order to minimize the generation
of shearing-type forces, illustrative interface surfaces
5 414a and 416a of end portion 412 are advantageously
made to be contoured.

Of the numerous specific geometries which may
be employed as practical realizations of such shearing-
reduced edge contours, FIGS. 4b and 4c respectively
10 schematically illustrate the use of first rounded and
then chamfered surface portions for the fuse-body ends.
FIG. 4b shows surface portion 413b to be substan-
tially rounded, thus significantly reducing the
severity of the surface geometry otherwise presented
15 by conventionally-experienced edge 415b. Similarly,
FIG. 4c illustrates the manner in which the chamfered
surface portion 413c may be employed to again reduce
the severity of the conventionally-experienced edge 415c
by effectively substituting the more-relaxed edge
20 surfaces 414c and 416c.

B. Surface Metalization

The previously-referenced surface metalization
applied to the connective portions of the fuse body
25 constitutes a second basic feature of the subject
electrical fuse.

The metal chosen for the metalization process
is preferably of a nature which is conducive to the
subsequently-performed bonding of the fusible element to
30 the metalization surface. In a preferred situation
where a below-described particular form of welding is
to be utilized for this bonding, it is convenient to
employ either molybdenum-manganese (commonly referred
to as moly manganese) or tungsten as the metalization
35 material.



1 For the similarly more-specific situation
where the fuse body includes end portions configured to
receive end caps, the metal is also preferably conducive
to the connective mounting of such caps. Because the
5 connective mounting typically includes a solder joint,
it is to joints of this nature which the metal should
most-specifically also be conducive. It may be noted
that the above-identified exemplary molybdenum and
tungsten each possess this supplemental conductivity.

10 Conventional processes may be employed to apply
such metalizations to the appropriate portions of the
fuse body. In a preferred form of the invention,
however, the metalization-application process is
specified to include a co-firing of the metalization
15 along with the final curing of the preferred ceramic
body. Alternatively, although somewhat less advan-
tageously, the metalization may be baked onto a
substantially-finished ceramic body.

20 The metalization processing itself preferably
concludes with the various metalized layers being
subjected to a surface-finishing operation designed to
provide the metals with both anti-corrosion protection
and enhanced bondability to the fusible element. Where
the fuse is again more-specifically configured for the
25 mounting of end caps, the surface finishing is preferably
designed to also provide enhanced joinability to the
associated caps. A variety of plating-type surface
finishings may be employed for the simultaneous achieve-
ment of these objectives. The conventionally-applied
30 finishing may, for example, more-specifically take the
form of either gold over nickel or solder plate over
nickel.

1 The portions of the fuse body selected to
receive metalization are, as a minimum, those expected
to be contacted by the fusible element. Although it is
usually convenient to specify, in the particularized
5 case of an elongated fuse body, for example, that
metalization layer 418 be applied to at least the
exterior end surface 403, it is often further convenient
to provide that the metalization be applied around the
entire exterior of the end of the fuse body up to the
10 illustrated depth e--e and include the illustrated
extension 419 onto the contoured end surface 404. In a
more-specific embodiment of this nature, the fuse's
connective portions become simply the entire respective
metalized ends.

15

C. Fusible Element

A third basic feature of the subject electrical
fuse is its fusible element. Within the inventive fuse,
this element performs the essentially-conventional
20 function of circuit interruption by melting upon
overload. While an element which performs this function
may take on any number of specific geometries, the
element of whatever form will possess at least two
connective portions which are to be bonded to the
25 surface-metalized connective portions of the fuse body.
For the sake of sequential consistency with those fuse-
body portions which have previously been ordinarily
identified as first and second connective portions,
the subject portions of the fusible element are in turn
30 identified as third and fourth connective portions. It
then becomes convenient to reiterate that for the
inventive fuse these third and fourth portions of the
fusible element are respectively bonded to the surface
metalization associated with the first and second
35 connective portions of the fuse body.



1 The fusible element may more-generally be
regarded as including a plurality of sections, with
the elements' connective portions comprising selected
segments of such sections. Where, as previously-
5 discussed, the fuse body has been more-specifically
configured to include a receptacle adapted to protectively
carry the fusible element, it is also more-specifically
a selected one of the referred sections which is inter-
posed in the fuse-body receptacle.

10 It is often convenient, especially where an
essentially-elongated fuse body is being employed, to
additionally provide that the fusible element likewise
be essentially elongated and include a central section.
In such a case, a protective receptacle for an associated,
15 substantially-elongated fuse body may comprise an
elongated conduit. It then becomes further convenient
to provide that it be the fusible element's central
section which is interposed in the elongated conduit.

 Thus with reference to FIG. 5, the fuse body 510
20 is seen to be of the preferred, substantially-tubular
form which includes a central axial shaft 515. An
otherwise-conventional, substantially-elongated fusible
element 520, having a first end-section 522, a second
end-section 527 and a central section 528 is shown to
25 be interposed in shaft 515 and folded around the
previously-described contoured edge surfaces of the
fuse body 510.

 At contoured fuse end 512, containing the
previously-described surface-metalization layer 518,
30 third connective portion 523 of the fusible element is
bonded to the given associated segment of the layer
518. (A similar bonding is formed with respect to the
fourth connective portion 529 at second fusible-element
end 527.) A number of techniques may be employed to

35



1 effectuate the subject bonding, with one such suitable
technique comprising a conventional welding process.
The welding may in turn comprise a variety of more-
specific forms. A preferred technique utilizes the
5 precision "parallel-gap" type series welding operation
made possible by the Model VTA-66 Parallel Gap Weld
Head available from the Industrial Products Division
(Carlsbad, California) of the Hughes Aircraft Company.
Side portion 523 is thus illustrated as being bonded to
10 layer 518 by means of parallel-gap weld 525.

By means of the described bonding, the fusible
element becomes securely joined to the fuse body. The
bonding thus provides a positive physical interlock
between the fusible element and the body, an interlock
15 which is essentially unalterable during subsequent
operations involving the ordinary application of elevated
processing temperatures. Furthermore, for those
instances where the fuse body is configured to receive
end caps, the bonding would be completed prior to the
20 mounting of the caps and hence a pre-capping visual
inspection of the respective bonds would be readily
facilitated.

It may be noted that it may be advantageous to
specify that the central section 528 of elongated fusible
25 element 520 be supplied at fabrication with sufficient
slack so as to provide tolerance of subsequently-
experienced temperature fluctuations. Such tolerance
helps prevent alterations in electrical properties
which result from fusible element cross-sectional changes
30 caused by differentials in the thermal-expansion
characteristics between the typically-metallic fusible
element and the typically-ceramic fuse body.

It may be further noted that in certain circum-
stances mass production of the subject fuse may be
35 facilitated by alternatively looping element end section
527 around body-end segment 517a instead of around

- 1 segment 517b. With both end sections of the fusible
element disposed on a common side 511 of the fuse body,
the bonding of both ends could then be effectuated
from a single side of the fuse. A single-side bonding
5 of this nature could facilitate production by eliminating
the necessity for a typically less-efficient intermediate
step of body rotation between the bonding of one end
and the next.

10 D. Stabilized End Caps

- In the more-specific situations where the fuse
body includes first and second end portions, such
portions may yet-more-specifically be configured to
respectively receive first and second end-cap assemblies.
15 Such assemblies connectively encase the associated
connective portions of the fusible element. The
encasement is "connective" in that when the assemblies
are mounted on the respective end portions, an electrical
connection is established between the assemblies and the
20 respective connective portions of the given element.

- The particular means utilized to effectuate this
electrical connection may tend to be a function of the
specific characteristics of a given actual embodiment
for the subject fuse. It may be noted parenthetically,
25 however, that in view of the previously-discussed
bonding between the fusible element and the metalization,
the required cap-to-fusible-element connection may be
established "indirectly" by way of an electrical
connection between the assemblies and the appropriate
30 metalization layers. Thus, for example, in larger-
scale embodiments where the given end portions possess
adequate compressive strength, the subject connection
may be established by simply crimping the assembly end
caps onto the associated end portions so that the
35 crimped portions of the caps physically contact either
the fusible element itself or at least the associated

1 metalization. In smaller-scale embodiments where the
end portions lack the requisite compressive strength,
as well as in embodiments of arbitrary scale where
auxiliary considerations such as end-portion hermeticity
5 are operative, a solder joint between the end-cap assembly
and either or both of the fusible element and the
metalization may, for example, alternatively be employed.

The end-cap assembly itself may take a variety
of specific forms. Such forms will typically include a
10 separately-identifiable end cap. This end cap may more-
specifically be configured to both receive the terminal
end of a lead wire and hold this wire substantially
juxtaposed the fuse-body end portion on which the
assembly is mounted. Where the end cap is specifically
15 configured in this fashion, the end-cap assembly may
be regarded as including both the end cap itself and
the lead wire. Furthermore, for those specific
embodiments where a solder joint is employed as the
means which establishes the requisite electrical
20 connection, the assembly may similarly be regarded as
including the solder joint as well.

Although the general nature of the cap assemblies
will be further discussed in the context of the composite
embodiment illustrated in FIGS. 7a and 7b, certain
25 unique aspects of the preferred forms of the caps them-
selves will now be described with reference to FIGS. 6a,
6b, 6c, 6d and 6e. A given fuse-body end portion and its
associated mounted assembly may be regarded as establishing
a fuse/cap interface. In the preferred form of the
30 invention, this interface is configured so as to generally
include appropriate geometrical mechanisms for stabilizing
the mechanical positioning of the given assembly on the
associated end portion. Such stabilization mechanisms
may be realized by means of impressions integrally
35 formed within the caps themselves. Of the yet-more-
specific realizations for the stabilization mechanisms

1 in general and for the impressions in particular,
indentations or flats integrally formed in the cap may
be employed. Example indentations of this nature are
illustrated in FIGS. 6a and 6b, while example flats are
5 presented in FIG. 6d.

In the transverse cross section of FIG. 6a,
the end cap 630 is illustrated as encasing an end of
fuse body 610. Cap 630 is shown to include a plurality
of integral impressions whose specific forms are the
10 illustrated indentations 632a, 634a and 636a which abut
the fuse body at respective interface surfaces 612, 614
and 616. The described impressions are preferably
configured so as to be mutually symmetrically disposed
around the periphery of the encased fuse-body end portion
15 when the given cap is thereon mounted. It may be noted
that in the specific situation of a tubular fuse body,
the symmetrical peripheral encasement may typically take
the illustrated form of a circumferential disposition
at approximately 120° intervals. The inherent stability
20 of the resulting concentric relationship between the
end cap and the fuse body is readily apparent. A
typical connective interposition for fusible element
620 is also illustrated.

A longitudinal cross-sectional view of this end-
25 cap configuration is presented in FIG. 6b. End cap 630
is again shown to be encasing an end portion 611
of fuse-body 610 while also shown to be of the specific
type which is configured to receive terminal end 655 of
lead wire 650 and hold this wire end substantially
30 juxtaposed the fuse-body end portion 611. Indenta-
tions 632b and 634b are two of the typically three
symmetrically-disposed stabilizing indentations. Of the
various alternative cross-sectional forms again possible
for the impressions in general and the indentations in
35 particular, the indentations 632c and 634c are shown in



1 FIG. 6c to be of a preferred, elongated variety extending
to edge 631 of cap 630c, thus creating, for example, an
extended-surface interface 612c between the end cap and
the fuse-body end portion 611.

5 In FIG. 6d is shown the alternative realization
in which flats 632d, 634d and 636d, integrally-formed
within end cap 630d and abutting fuse body 610d, are
the specific forms of the stabilizing impressions. By
10 analogy to the elongated impressions illustrated in
the cross-sectional view of FIG. 6c, the flats of
FIG. 6d may similarly be of an elongated nature.

An alternative of a slightly-different specific
nature is presented in FIG. 6e. Here the geometrical
stabilization is provided by a specially-configured
15 cross section for fuse body 610e instead of by alterations
for end cap 630e. Other substantially-equivalent
stabilization geometries for both the fuse body and the
end caps will be readily apparent.

20 E. Composite Embodiment

A composite preferred realization of an
electrical fuse constructed in accordance with principles
of the present invention is illustrated in FIGS. 7a and
7b. The longitudinal cross-sectional view of FIG. 7a
25 shows the fuse 700 with elongated tubular body 710,
axial shaft 715 and elongated fusible element 720.
First end-cap assembly 735 is shown as including first
end cap 730, solder medium 770 and lead wire 750 with
terminal end 755 held substantially juxtaposed first
30 fuse-body end 712. Cap 730 is seen to contain the
elongated stabilizing indentation 736, while the con-
nective portion 723 of the fusible-element end 722 is
shown to be bonded, by means of parallel-gap weld 725,
to metalization 718 formed around contoured end surfaces
35 714 and 716 and onto connective surface 701. Solder

1 medium 770 electrically joins end cap 730 to metalization
layer 718 and to fusible-element end 722. Shrink
sleeve 790 encases the composite fuse.

5 With reference to the transverse cross-sectional
view of FIG. 7b, taken along line a--a of FIG. 7a, end
cap 730 is shown to be stabilized over the end of fuse
body 710 by means of integrally-formed impressions 732,
734 and 736. Electrically joining end cap 730 both to
10 metalization surface 718 and to interposed fusible
element end 722 is the joining medium comprised of
solder 770. The metalization surface 718, by means of
its induced capillary action, is shown to have effectuated
not only a uniform electrical interface between the cap
730, the surface 718 and the interposed fusible element
15 end 722, but also a fuse-body-end seal of significantly-
enhanced hermeticity.

III. Claims

20 The preceding description has presented in detail
exemplary preferred ways in which the concepts of the
present invention may be applied. Those skilled in the
art will recognize that numerous alternatives encompassing
many variations may readily be employed without departing
25 from the spirit and scope of the invention as set forth
in the appended claims, in which:

30

35



CLAIMSWhat is claimed is:

- 1 1. An electrical fuse comprising:
- (A) a body having first and second connective
5 portions;
- (B) surface metalization applied to said
 connective portions; and
- (C) a fusible element having third and fourth
10 connective portions, said third and fourth portions
 being respectively bonded to the surface metalization
 of said first and second portions.



1 2. A fuse according to Claim 1 in which:

 said fuse body comprises a ceramic material
which is conducive to the application of said surface
5 metalization.

- 1 3. A fuse according to Claim 2 in which:
- said ceramic material comprises alumina.



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4. A fuse according to Claim 3 in which:

said alumina ceramic comprises at least
approximately 92% alumina.



- 1 5. A fuse according to Claim 1 in which:

 said metalization comprises molymanegese.



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6. A fuse according to Claim 1 in which:

said metalization comprises tungsten.



1 7. A fuse according to Claim 2 in which:

 said metalization is co-fired with said
ceramic material.



1 8. A fuse according to Claim 2 in which:

 said metalization is baked onto a
substantially-finished ceramic body.



1 9. A fuse according to Claim 1 in which:

 said metalization is finished with gold over
nickel.

1 10. A fuse according to Claim 1 in which:

 said metalization is finished with solder
plate over nickel.



1 11. A fuse according to Claim 1 in which:

 the bonding of said third and fourth connective
portions of said fusible element to the surface metalization
5 of the associated first and second connective portions
of said fuse body comprises a weld.

- 1 12. A fuse according to Claim 11 in which:

 said weld comprises a parallel-gap weld.



1 13. A fuse according to Claim 1 in which:

 (A) said fuse body includes surfaces of
critical interface between the fusible element and the
5 fuse body; and

 (B) such surfaces include contoured edges.



1 14. A fuse according to Claim 13 in which:

said contoured edges include substantially-
rounded portions.



1 15. A fuse according to Claim 13 in which:

 said contoured edges include substantially-
chamfered portions.



1 16. A fuse according to Claim 1 in which:

 said fuse body includes first and second end
portions, with said first and second connective portions
5 respectively comprising selected sections of said first
and second end portions.

1 17. A fuse according to Claim 16 further including:

 first and second end-cap assemblies, respectively
mounted on said first and second fuse-body end portions
5 and each connectively encasing the associated connective
portion of said fusible element.

1 18. A fuse according to Claim 17 in which:

5 (A) each of said first and second fuse-body
end portions and the associated mounted end-cap assemblies
establish respective first and second fuse/cap interfaces;
and

10 (B) each of said interfaces includes
geometrical means for stabilizing the positioning of
the associated end-cap assembly on the associated
fuse-body end portion.

1 19. A fuse according to Claim 18 in which:

(A) each of said assemblies includes an end
cap; and

5

(B) said geometrical means comprise impressions
integrally formed in each of said end caps.

1 20. A fuse according to Claim 19 in which:

 said impressions comprise enlongated
indentations.

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21. A fuse according to Claim 19 in which:

said impressions comprise elongated flats.

1 22. A fuse according to Claim 19 in which:

5 each of said caps include a plurality of said
impressions, configured so as to be mutually symmetrically
disposed around the periphery of the associated fuse-body
end portion when the given cap is thereon mounted.



1 23. A fuse according to Claim 17 in which:

(A) each of said end-cap assemblies includes
a lead wire having a terminal end; and

5

(B) each of said assemblies is configured
to hold the associated terminal end substantially
juxtaposed the associated fuse-body end portions.



1 25. A fuse according to Claim 1 in which:

 (A) said fuse body includes a receptacle
adapted to protectively carry the fusible element; and

5

 (B) said fusible element includes a plurality
of sections, with one of said sections being interposed
in said receptacle.



1 26. A fuse according to Claim 25 in which:

(A) said fuse body is substantially elongated
and said receptacle comprises an elongated conduit; and

5

(B) said fusible element is substantially
elongated and includes a central section, with said
central section being the section interposed in said
elongated conduit.



1 27. A fuse according to Claim 26 in which:

 (A) said fuse body is substantially tubular;
and

5

 (B) said elongated conduit comprises an
axial shaft.



1 28. A fuse according to Claim 1 in which:

 said fusible element is slacked during fuse
manufacture so as to provide thermal tolerance of
5 subsequently-experienced temperature fluctuations.



- 1 29. A fuse according to Claim 1 in which:
 said fusible element is substantially elongated.

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30. A fuse according to Claim 1 in which:

said fuse body is substantially elongated.

- 1 31. A fuse according to Claim 1 in which:
- said fuse body is substantially tubular.

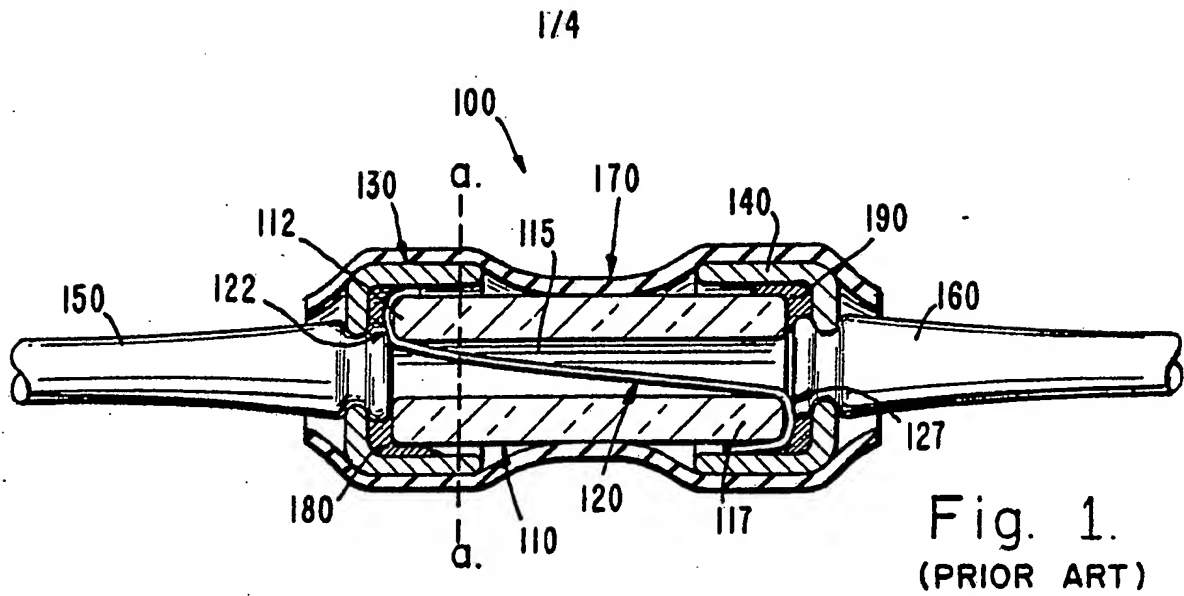


Fig. 2a.
(PRIOR ART)

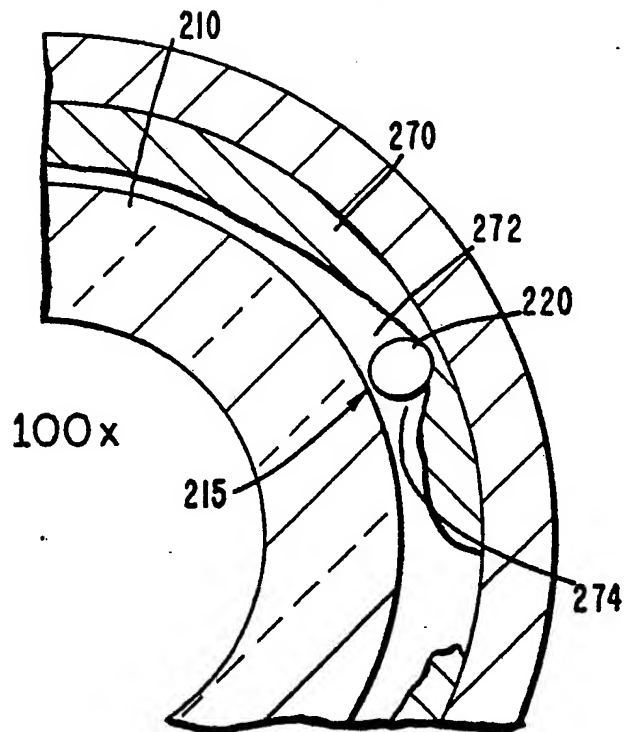
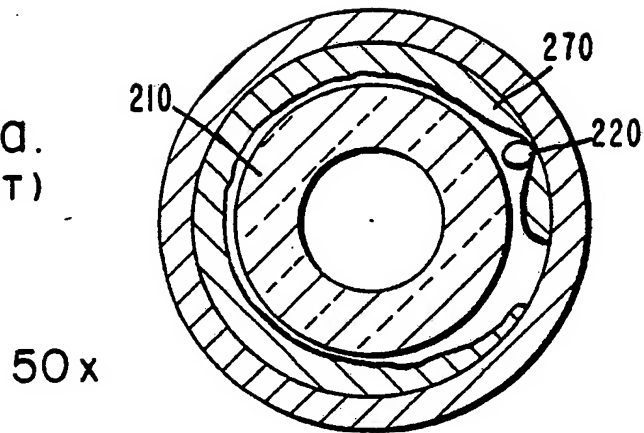


Fig. 2b.
(PRIOR ART)

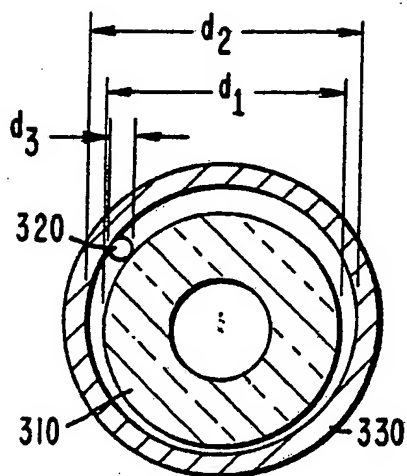
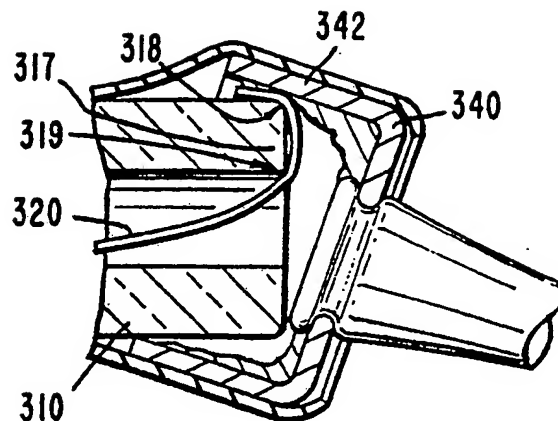
Fig. 3a.
(PRIOR ART)Fig. 3b.
(PRIOR ART)

Fig. 4a.

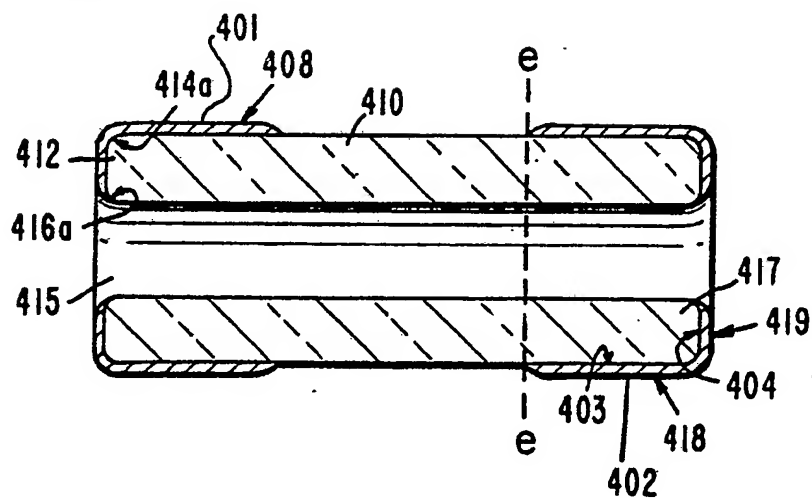


Fig. 4b.

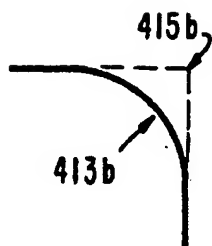


Fig. 4c.

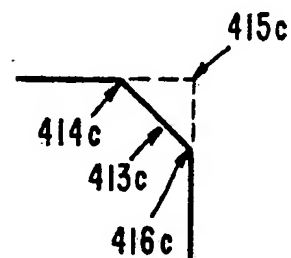


Fig. 5.

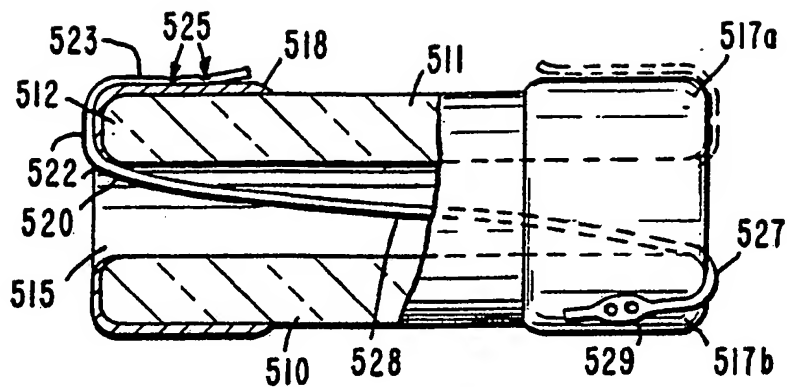


Fig. 6a.

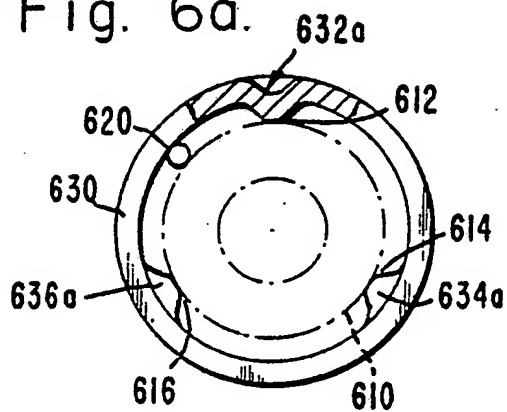


Fig. 6b.

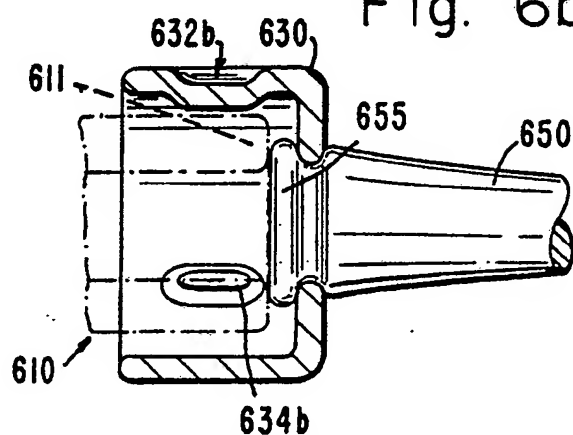


Fig. 6c.

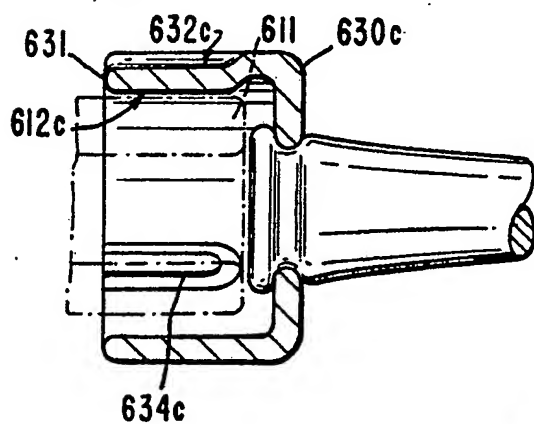


Fig. 6d.

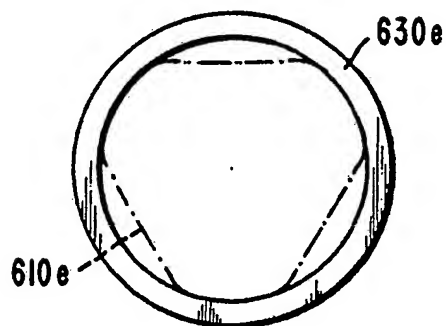
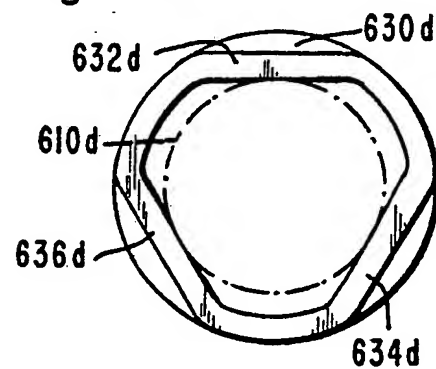


Fig. 6e.

Fig. 7a.

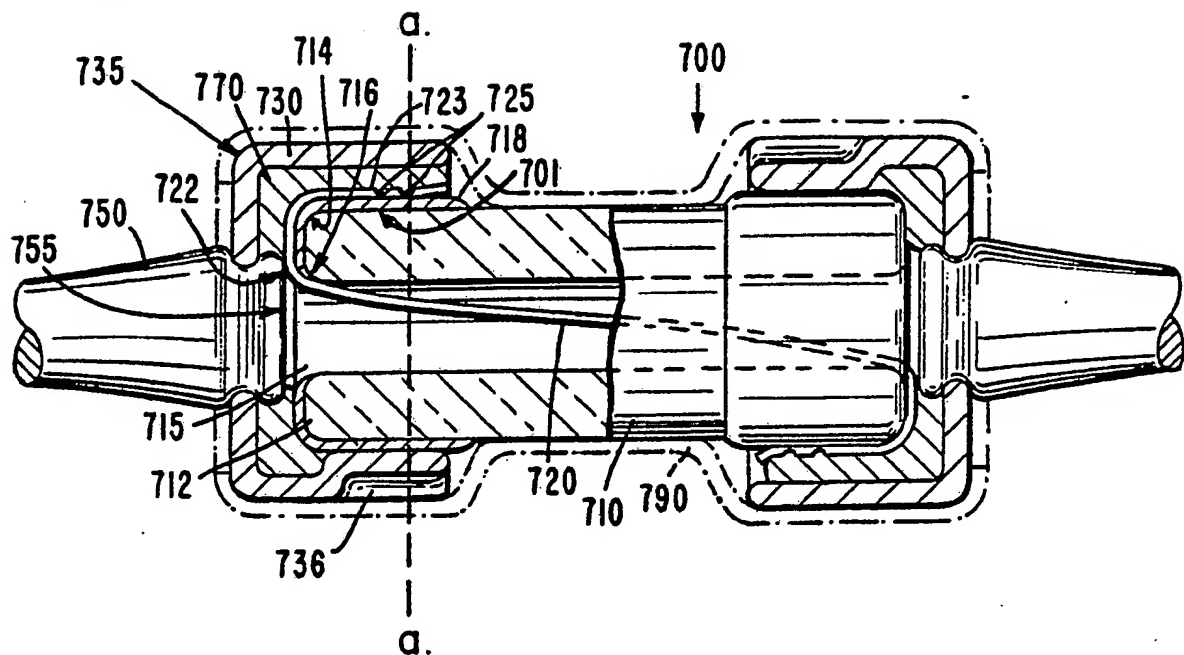
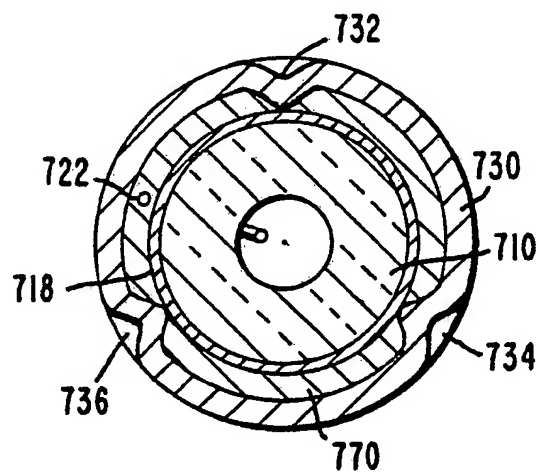


Fig. 7b.



INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 83/01880

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
IPC ³ : H 01 H 85/16; H 01 H 85/04		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
Classification System	Classification Symbols	
IPC ³	H 01 H 85/00; H 01 H 69/00; C 04 B 37/00	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category ⁶	Citation of Document, ¹⁵ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	GB, A, 580759 (BELLING) 17 October 1946 see the entire document	1, 16, 17, 24- 27, 29-31
Y	--	13-15, 18-23, 28
Y	FR, A, 1388045 (ARNOULD) 1965 see the entire document	13-15
Y	GB, A, 1312033 (DORMAN) 4 April 1973 see the entire document	18-20, 22
Y	CH, A, 257559 (WEBER) 16 April 1949 see the entire document	18, 19, 21, 22
Y	US, A, 3505630 (MERRILL) 7 April 1970 see figure 4; column 4, lines 13-35	23
Y	US, A, 2682587 (BURT) 29 June 1954 see the entire document	28
	US, A, 3913051 (Mc GRAW-EDISON) 14 October 1975	./.
⁹ Special categories of cited documents: ¹⁶ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "A" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ²	Date of Mailing of this International Search Report ³	
1st August 1984	21 AUG 1984	
International Searching Authority ¹	Signature of Authorized Officer ¹⁰	
EUROPEAN PATENT OFFICE	G.L.M. Kruidenberg	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No ¹⁸
X	see column 3, line 17 - column 4, line 49	1-3, 16, 29, 30
Y	--	4-12
Y	GB, A, 864017 (BELLING) 29 March 1961 see page 1, column 2, lines 73-83	4
Y	--	
Y	CH, A, 363928 (EITEL-McCULLOUGH) 28 September 1962 see page 1, lines 22-41	5, 7, 8
Y	--	
Y	DE, C, 954040 (GENERAL ELECTRIC) 22 November 1962 see page 1, line 1 - page 3, column 1, line 40	6-8
Y	--	
Y	CH, A, 378765 (CERBERUS) 31 July 1964 see page 4, line 102 - page 5, line 11; page 5, lines 23-52 and 74-81	7-9
Y	--	
Y	DE, C, 848623 (TELEFUNKEN) 27 December 1951 see page 2, lines 79-92	7, 8, 10
Y	--	
Y	US, A, 3261951 (JACOBS) 19 July 1966 see column 2, lines 3-12	11, 12
X	--	
X	US, A, 2576405 (McALISTER) 27 November 1951 see column 4, line 53 - column 6, line 71	1
A	--	
A	GB, A, 540130 (ELECTRICAL TRANSMISSION LIMITED) 8 April 1946 see page 1, lines 36-49; page 2, lines 55-60; page 4, lines 44-56	1, 2

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET
V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹⁰

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers _____, because they relate to subject matter ¹² not required to be searched by this Authority, namely:

2. ☐ Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out ¹³, specifically:

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ¹¹

This International Searching Authority found multiple inventions in this international application as follows:

- 1-4 : Use of a metallization conductive ceramic for a fuse body
- 5-12 : Metallization and bonding of the fusible element thereto
- 13-30 : Constructional details relating to the body, its end caps and the mounting of the fusible element

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☒ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO.

PCT/US 83/01880 (SA 6163)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 15/08/84

The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 580759		None	
FR-A- 1388045		None	
GB-A- 1312033	04/04/73	None	
CH-A- 257559		None	
US-A- 3505630	07/04/70	None	
US-A- 2682587		None	
US-A- 3913051	14/10/75	None	
GB-A- 864017		None	
CH-A- 363928		None	
DE-C- 954040		None	
CH-A- 378765		None	
DE-C- 848623		None	
US-A- 3261951		None	
US-A- 2576405		None	
GB-A- 540130		None	

For more details about this annex :
see Official Journal of the European Patent Office, No. 12/82

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